

Two new and one newly recorded species of *Simulium* (Diptera: Simuliidae) from Palawan Island, the Philippines

Hiroyuki TAKAOKA¹⁾ and Victor F. TENEDERO²⁾

¹⁾ Department of Infectious Disease Control, Faculty of Medicine,
Oita University, Hasama, Yufu City, Oita, 879–5593 Japan

²⁾ West Ayala Condominium, 252 Sen. Gill. Puyat Ave.,
Makati, Metro Manila, 1,200 Philippines

(Received: 9 April 2007; Accepted: 25 May 2007)

Abstract: Twelve species of black flies including two new and one newly recorded species were collected from Palawan Island, the Philippines. *Simulium* (*Gomphostilbia*) *babuyanense* sp. nov. and *S. (G.) batakense* sp. nov. are described from one male and one female each reared from the pupa, respectively. The male of *S. (G.) mangasepi* Takaoka and the female of *S. (S.) latistylum* Takaoka are described for the first time. *Simulium* (*Wallacellum*) *tuyense* Takaoka is recorded for the first time from Palawan Island.

Key words: black fly, Simuliidae, Palawan, Philippines, description

The black-fly fauna of Palawan Island, the Philippines, consists of 16 species of the genus *Simulium* Latreille, of which two are placed in the subgenus *Nevermannia*, five in the subgenus *Gomphostilbia*, and nine in the subgenus *Simulium* s. str. (Delfinado, 1971; Takaoka, 1983, 2003).

Recently we investigated the pupae and larvae of black flies at 13 stream or river sites in Palawan Island and collected a total of 12 species including two new species of *Simulium* (*Gomphostilbia*) and one newly recorded species of *Simulium* (*Wallacellum*). In this paper, these two new species are described on the basis of the reared adults and pupae, and the male of *S. (G.) mangasepi* Takaoka and the female of *S. (S.) latistylum* Takaoka, both of which have remained unknown, are described for the first time.

The terms for morphological features, as well as the methods of collection, rearing, description and measurement used in this study followed Takaoka (2003). All female and male adult specimens examined were those reared from pupae and

preserved together with their pupal exuviae and cocoon in 80% ethanol. The keys provided by Takaoka (1983) were used for species identification. Holotype specimens of the new species are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

In addition, all the larvae collected were examined under a dissecting microscope for mermithid, microsporidan and fungal infections. These infections were diagnosed by the signs and symptoms of the larvae characteristic for each group of pathogens (Crosskey, 1990).

The Species of Simuliidae from Palawan Island

1. *Simulium* (*Gomphostilbia*) *alienigenum* Takaoka

Simulium (*Morops*) *alienigenum* Takaoka, 1983: 55–58 (female, male, pupa and larva).

Simulium (*Gomphostilbia*) *alienigenum* Takaoka, 2003: 54.

This species was first assigned to the subgenus *Morops* (Takaoka, 1983), but later transferred to the *banauense* species-group, proposed within the subgenus *Gomphostilbia* (Takaoka, 2003). This species is distinctive in having fine setae on the sclerotized region just anterior to the pleural membrane of the adult thorax, female claw with a medium-sized subbasal tooth, and pupal gill with four filaments (Takaoka, 1983).

SPECIMENS EXAMINED. 1 female and 3 males, collected from a slow-flowing small stream (Col. no. 3) (width 2 m, stream bed sand, water temperature 24°C, exposed to sun, altitude 40 m) just downstream of the Binuan Bridge at the point where the main road from Puerto Princesa to Brooks Point branches off to Montible, 28. I. 2007, by H. Takaoka and V.F. Tenedero; 2 males, 3 mature larvae and 4 immature larvae, collected from a moderately flowing main channel of the Balsahan River (Col. no. 13) (width 3–8 m, partially shaded, water temperature 25.0°C, altitude 42 m), Iwahig Colony, 1. II. 2007, by H. Takaoka.

ECOLOGICAL NOTES. The pupae and larvae of this species were collected from leaves of trailing grasses. Associated species were *S. (G.) epistum* Takaoka, *S. (G.) mangasepi*, *S. (S.) iwahigense* Takaoka, *S. (S.) latistylum*, *S. (S.) quasifrenum* Delfinado, and *S. (W.) tuyense* Takaoka. None of the seven larvae examined was infected with mermithids, microsporidians or fungi.

DISTRIBUTION. Philippines (Palawan).

2. *Simulium (Gomphostilbia) babuyanense* sp. nov.

DESCRIPTION. Male. Body length 2.3 mm. **Head.** Wider than thorax. Upper eye consisting of 14 vertical columns and 14 horizontal rows of large facets. Face dark brown, white pruinose. Clypeus dark brown, densely covered with yellow scale-like short to medium-long hairs (mostly directed upwards) interspersed with several dark brown simple longer hairs near lower margin. Antenna composed of

scape, pedicel and 9 flagellomeres, dark brown except scape, pedicel, and base of 1st flagellomere whitish-yellow, and rest of 1st flagellomere and 2nd flagellomere dark yellow or light brown when viewed anteriorly; 1st flagellomere elongate, about 1.57 times as long as 2nd flagellomere. Maxillary palp with 5 segments, light brown, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.33 : 2.89; 3rd segment (Fig. 1A) of moderate size; sensory vesicle (Fig. 1A) nearly globular, small, 0.26 times as long as 3rd segment, and with medium-sized opening. **Thorax.** Scutum black, shiny and whitish-gray pruinose except median vitta and submedian round spots not shiny and non-pruinose (Fig. 1B), and moderately covered with copper-colored and dark brown short hairs intermixed with a few dark brown upright longer hairs on each posterolateral margin; scutellum brownish-black, with copper-colored short hairs and dark brown long upright hairs along posterior margin. Postnotum brownish-black, whitish-gray pruinose narrowly along anterior margin, and bare. Pleural membrane bare. Katepisternum brownish-black, longer than deep, moderately covered with copper-colored short hairs. **Legs.** Foreleg: coxa yellow; trochanter dark yellow to light brown; femur light brown except apical cap medium brown; tibia medium brown except median 1/3 pale light brown; tibia white sheeny extensively on outer surface when viewed at certain angle of light; tarsus dark brown to brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 5.9 times as long as its greatest width. Midleg: coxa dark brown; trochanter light brown except base dark yellow; femur medium to dark brown with extreme base somewhat paler; tibia and tarsus dark brown to brownish-black. Hind leg: coxa dark brown; trochanter dark yellow; femur medium to dark brown with extreme base dark yellow; tibia dark brown to brownish-black except extreme base dark yellow; tarsus dark brown to brownish-black except basal 2/3 of basitarsus and basal 1/3 of 2nd tarsal segment yellowish though base of basitarsus dark brown; basitarsus (Fig. 1C) narrow, nearly parallel-sided, 5.91 times as long as wide, and 0.62 times as wide as greatest widths of tibia and femur; calcipala slightly longer than width at base, and 0.48 times as wide as greatest width of basitarsus. **Wing.** Length 1.6 mm. Costa with dark spinules and

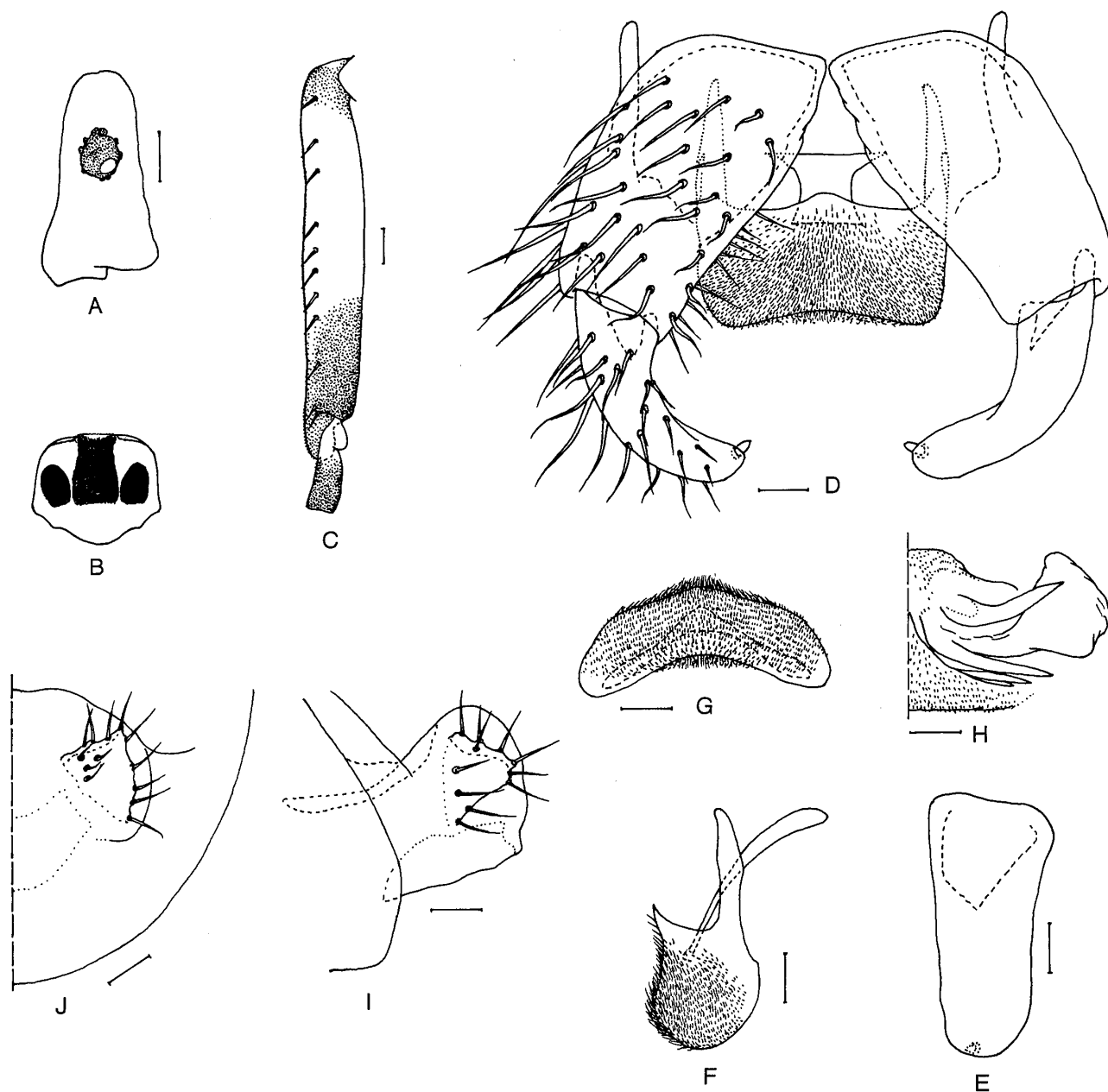


Fig. 1. Male of *Simulium (Gomphostilbia) babuyanense* sp. nov. A, 3rd segment of maxillary palp with sensory vesicle (right side and front view); B, scutum; C, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); D, coxites, styles, median sclerite and ventral plate *in situ* (ventral view); E, style (right side and ventrolateral view); F, ventral plate and median sclerite (lateral view); G, ventral plate (end view); H, paramere and aedeagal membrane (left side and end view); I and J, cerci (I, right side and lateral view; J, left side and end view). Scale bars. 0.04 mm for C; 0.02 mm for A and D–J.

hairs. Subcosta bare. Hair tuft on stem vein dark brown. Basal portion of radius fully haired; R_1 with dark spinules and hairs; R_2 with hairs only. Basal cell absent. **Abdomen.** Basal scale brownish-black, with fringe of light brown hairs. Dorsal surface of abdomen brownish-black except basal 2/3 of 2nd segment yellow to dark yellow, and rest of 2nd segment and 3rd segment light to medium

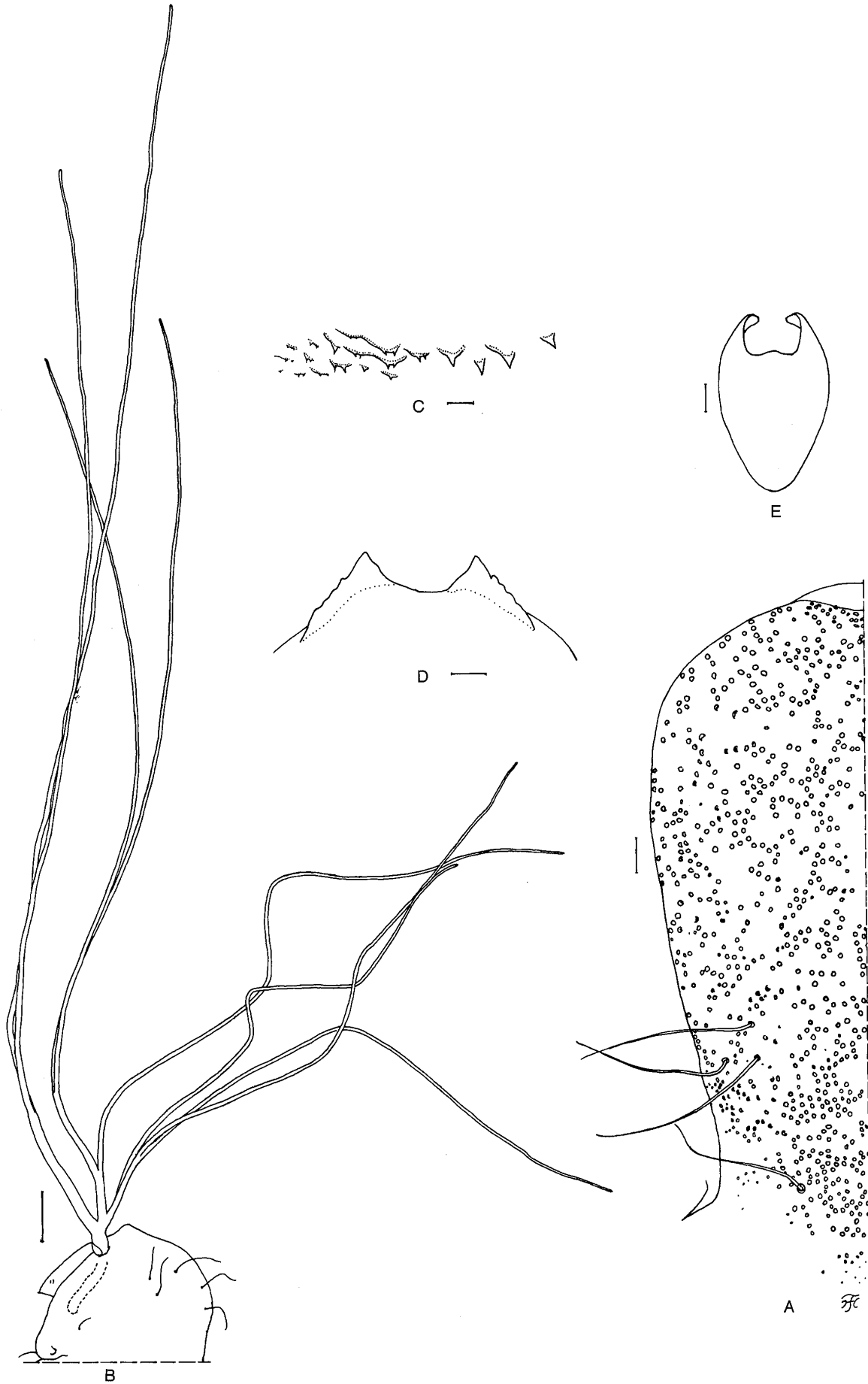
brown, and covered with dark short to long hairs; segments 2 and 5–7 each with pair of shiny whitish-gray pruinose dorsolateral patches, of which those on segment 2 broadly connected in middle to each other, and those on segments 5–7 narrowly connected to each other along anterior margin. **Genitalia.** Coxite in ventral view (Fig. 1D) nearly rectangular, about 1.8 times as long as its greatest width.

Style in ventral view (Fig. 1D) slender, tapered toward apex, 0.83 times as long as coxite, gently bent inward, with apical spine; style in ventrolateral view (Fig. 1E) very slightly tapered toward apex, with blunt apex. Ventral plate in ventral view (Fig. 1D) transverse, 0.56 times as long as wide, nearly parallel-sided, with anterior margin produced anteromedially, and posterior margin concave medially, and densely covered with microsetae on ventral surface; basal arms of moderate length, nearly parallel-sided; ventral plate in lateral view (Fig. 1F) slightly produced ventrally; ventral plate in end view (Fig. 1G) rounded ventrally, and densely covered with microsetae on posterior surface. Median sclerite (Fig. 1D) thin, plate-like, wide, and connected to ventral plate near anterior margin. Paramere (Fig. 1H) of moderate size, each with 4 or 5 distinct long and stout hooks and several smaller ones close together near apex. Aedeagal membrane (Fig. 1H) moderately setose. Ventral surface of 10th abdominal segment thinly sclerotized anteriorly, without distinct hairs near posterior margin on each side. Cercus (Fig. 1I, J) rounded, encircled with 11–13 hairs.

Pupa. Body length 2.5 mm. **Head.** Integument yellow to yellowish-brown, moderately covered with small round tubercles of almost equal size on frons (Fig. 2A) and each lateral surface but bare on antennal sheath and on underside of face; antennal sheath without any protuberances; frons with 3 pairs of simple very long trichomes with uncoiled apex, and face with pair of simple long trichomes with uncoiled apex; 3 frontal trichomes on each side arising close together, subequal in length to one another and slightly longer than facial one (Fig. 2A). **Thorax.** Integument yellow to yellowish-brown, moderately covered with round tubercles, with 3 simple very long trichomes with uncoiled apex dorsomedially, with 2 simple very long trichomes with uncoiled apex anterolaterally, and with 3 simple medium-long trichomes with uncoiled apex ventrolaterally on each side; trichomes on posterolateral surface broken basally and lost. Gill

(Fig. 2B) composed of 8 slender thread-like filaments, much longer than pupal body, arranged in $[(1+2)+(1+2)]+2$ filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally (partially broken) at base; upper and middle triplets sharing very short stalk arising from short common basal stalk; upper triplet composed of 1 individual and 2 paired filaments with medium-long stalk; middle triplet composed of 1 individual and 2 paired filaments with long stalk; stalk of ventral paired filaments very long, nearly as thick as interspiracular trunk, 1.4 times as thick as primary stalk of middle triplet which is 1.3 times as thick as that of dorsal triplet; stalk of upper triplet lying against that of lower pair nearly at angle of about 60 degrees when viewed laterally; all filaments light brown, gradually tapered toward apical tip, different in length and thickness from one another: i.e., inner filament of ventral pair longest (5.3 mm) and thickest of all, followed by outer filament of ventral pair (4.5 mm long) which is slightly thinner (i.e., 0.8 times as thick as its counter inner filament) and slightly shorter than its counter inner filament, filaments of dorsal triplet shortest (3.0–3.3 mm), those of middle triplet intermediate in length (3.8–3.9 mm), and filaments of upper and middle triplets subequal in thickness to one another, 0.57 times as thick as that of inner filament of ventral pair; cuticle of all filaments with well marked annular ridges and furrows though becoming less marked apically, densely covered with minute tubercles. **Abdomen.** Dorsally, all segments pale yellow; segments 1 and 2 each appearing to be very sparsely tuberculate partially; segment 1 with 1 simple slender medium-long hair-like seta on each side; segment 2 with 1 simple slender medium-long hair-like seta and 5 very short somewhat spinous setae, submedially on each side; segments 3 and 4 each with 4 hooked spines and 1 very short somewhat spinous seta on each side; segment 5 lacking spine-combs; segments 6–9 each with spine-combs in transverse row [though spine-combs (Fig. 2C) on segment 9 somewhat

Fig. 2. Pupa of *Simulium (Gomphostilbia) babuyanense* sp. nov. A, frons and portion of face (right half); B, gill filaments and anterior part of thoracic integument (left side and outer view), C, spine-combs and comb-like groups of minute spines on dorsal surface of abdominal segment 9 (left half and dorsal view); D, terminal hooks (end view); E, cocoon (dorsal view). Scale bars. 0.5 mm for E; 0.2 mm for B; 0.04 mm for A; 0.01 mm for C and D.



smaller than those on other segments], together with comb-like groups of minute spines on each side; segment 9 with pair of distinct flat plate-like terminal hooks extending laterally at base and having weakly serrate or undulate outer margin (Fig. 2D). Ventrally, segment 4 with 1 simple short hooklet and a few simple slender very short setae on each side; segment 5 with pair of bifid or trifid hooks submedially and a few very short simple slender setae on each side; segments 6 and 7 each with pair of bifid or trifid inner and simple outer hooks somewhat spaced from each other and a few very short simple slender setae on each side; segments 4–8 with comb-like groups of minute spines. Each side of segment 9 with 3 grapple-shaped hooklets. **Cocoon** (Fig. 2E). Wall-pocket-shaped, thinly and neatly woven, extending ventrolaterally; anterior margin somewhat thickly woven, slightly bulged dorso-medially; posterior 1/2 with floor moderately woven; individual threads visible; 3.3 mm long by 2.0 mm wide.

Female and Mature larva. Unknown.

TYPE SPECIMEN. Holotype male (with its associated pupal exuviae and cocoon) reared from pupa collected from a small stream (Col. no. 8) (width 3–5 m, stream bed sand, water temperature 29°C, exposed to sun, altitude 5 m), upstream of the Anilawan Bridge, Babuyan, near the main road from Puerto Princesa to El Nido, 30. I. 2007, by H. Takaoka and V. F. Tenedero.

ECOLOGICAL NOTES. The pupa of this species was collected from a bamboo leaf in a slow-flowing small stream. No other species was collected from the same stream.

ETYMOLOGY. The species name *babuyanense* refers to the name of the barangay, Babuyan, where this new species was collected.

REMARKS. According to the keys (Takaoka, 2003), *S. (G.) babuyanense* sp. nov. is readily assigned to the *batoense* species-group within the subgenus *Gomphostilbia* by having antennae with 11 segments, pleural membrane bare, and slender hind basitarsus (Fig. 1C) in the

male, and eight gill filaments (Fig. 2B) in the pupa.

This new species is characterized by pupal gill filaments, of which the inner filament of the ventral pair is very long (5.3 mm), i.e., twice the length of the pupal body, and is the longest and thickest of all (Fig. 2B). *Simulium (G.) pegalanense* Smart and Clifford described from Sabah (Smart and Clifford, 1969) has similarly arranged pupal gill filaments but terminal hooks are not serrated on the outer margin (according to the reexamination of the slide-mounted type specimen). The male of this known species seems to be similar to *S. (G.) babuyanense* sp. nov. in having dark legs and a slender hind basitarsus, but slightly differs in having enlarged upper-eye facets in 15 horizontal rows and in 15 or 16 vertical columns (according to the reexamination of the slide-mounted type specimen).

The male of *S. (G.) babuyanense* sp. nov. is distinguished from the known species of the *batoense* species-group so far reported from the Philippines by the scutal color pattern consisting of a median vitta and two submedian spots both non-pruinose against the rest of the surface that is whitish-gray pruinose and shiny (Fig. 1B). The similar scutal pattern has been reported in a few species, i.e., *S. (G.) friederichsi* Edwards from Java (Edwards, 1934), *S. (G.) hadiae* Takaoka from Sulawesi (Takaoka, 2003), *S. (G.) siamense* Takaoka and Suzuki from Thailand (Takaoka and Suzuki, 1984), and *S. (G.) yaeyamaense* Takaoka from the Ryukyu Islands (Takaoka, 1991). However, all these known species have different shapes in the median vitta and submedian spots, and the latter three known species also have pupal gill filaments that are much shorter (the longest ventral paired filaments are 2.0–2.7 mm long in *S. (G.) hadiae*, 2.5 mm long in *S. (G.) siamense* and 3.0–3.5 mm long in *S. (G.) yaeyamaense*) and differently arranged (e.g., two filaments of the ventral pair are subequal in length and thickness to each other).

3. *Simulium (Gomphostilbia) bataksense* sp. nov.

DESCRIPTION. Female. Body length 1.7 mm. **Head.** Slightly narrower than width of thorax. Frons dark brown, thinly grayish-white pruinose, shiny at certain angle of light, densely covered with yellowish-white scale-like recumbent short hairs interspersed with several dark simple longer hairs along each lateral margin; frontal ratio 1.94:1.00:2.59; frons-head ratio 1.00:4.31. Fronto-ocular area (Fig. 3A) well developed, narrow, directed dorsolaterally. Clypeus dark brown, grayish-white pruinose, densely covered with yellowish-white scale-like recumbent short hairs interspersed with about 10 dark longer hairs on each side. Labrum 0.55 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, medium brown except scape, pedicel, and base of 1st flagellomere whitish-yellow when viewed dorsally (1st flagellomere entirely whitish-yellow when viewed ventrally). Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.17:2.83; 3rd segment (Fig. 3B) somewhat swollen; sensory vesicle (Fig. 3B) oblong, 0.43 times as long as 3rd segment, with medium-sized opening medially. Maxillary lacinia with 9 inner and 12–14 outer teeth. Mandible with 22 inner and 9 outer teeth. Cibarium (Fig. 3C) medially forming round sclerotized plate folded forward from posterior margin, and with moderately sclerotized median longitudinal ridge. **Thorax.** Scutum medium brown (except anterior calli light brown), shiny, thinly grayish-white pruinose with 3 faint non-pruinose longitudinal vittae (1 median and 2 submedian) when illuminated dorsally and viewed anteriorly or posteriorly, moderately covered with yellowish-white scale-like recumbent hairs, and with 1 or 2 dark long upright hairs near each posterolateral margin. Scutellum medium brown, covered with dark brown short hairs as well as dark brown long upright hairs along posterior margin. Postnotum medium brown, shiny, thinly grayish-white pruinose when viewed at certain angle of light, and bare. Pleural membrane bare. Katepisternum medium brown, longer than deep, shiny, moderately covered with white and dark hairs. **Legs.** Foreleg: coxa whitish-yellow;

trochanter whitish-yellow with apical area of posterior surface dark yellow or light brown; femur light brown with apical cap medium brown; tibia white on basal 3/4 and brownish-black on apical 1/4; tibia densely covered with whitish fine hairs on outer surface of basal 3/4; tarsus brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 5.0 times as long as its greatest width. Midleg: coxa medium brown; trochanter yellow with apical 1/2 of posterior surface light brown; femur light brown with apical cap medium brown; tibia light to medium brown except slightly less than basal 1/3 white; tarsus dark brown to brownish-black except a little less than basal 1/2 dark yellow. Hind leg: coxa light brown; trochanter whitish-yellow; femur light to medium brown with extreme base whitish-yellow and apical cap dark brown; tibia (Fig. 3D) yellowish-white on a little more than basal 2/5, light brown on middle, and dark brown on apical 1/3; tibia densely covered with white fine hairs on posterior and outer surfaces of basal 2/3; tarsus dark brown except a little less than basal 2/3 of basitarsus (though base dark brown) and basal 1/3 of 2nd tarsal segment yellowish-white; basitarsus (Fig. 3E) narrow, nearly parallel-sided, 6.08 times as long as wide, and 0.76 and 0.61 times as wide as greatest widths of tibia and femur, respectively; calcipala nearly as long as wide, and 0.57 times as wide as greatest width of basitarsus. All femora, tibiae and parts of tarsus densely covered with dark (and also pale) scale-like hairs. Claw (Fig. 3F) with large basal tooth 0.47 times as long as claw. **Wing.** Length 1.6 mm. Costa with dark spinules and hairs. Subcosta with dark hairs except near apex bare. Hair tuft on stem vein medium brown. Basal portion of radius fully haired; R_1 with dark spinules and hairs; R_2 with hairs only. Basal cell absent. **Abdomen.** Basal scale light brown except middle 1/3 yellow, with fringe of whitish-yellow hairs (though basal portion of hairs dark). Dorsal surface of abdomen medium brown except basal 1/5 of segment 2 yellow, moderately covered with copper-colored short and dark brown long hairs; tergites of segments 2 and 6–9 wide and shiny, while those of segments 3–5 narrow, nearly quadrate, subequal in shape and size to one another, and all dull; ventral surface of segment 2 entirely pale whitish-yellow, and those of other segments light to medium

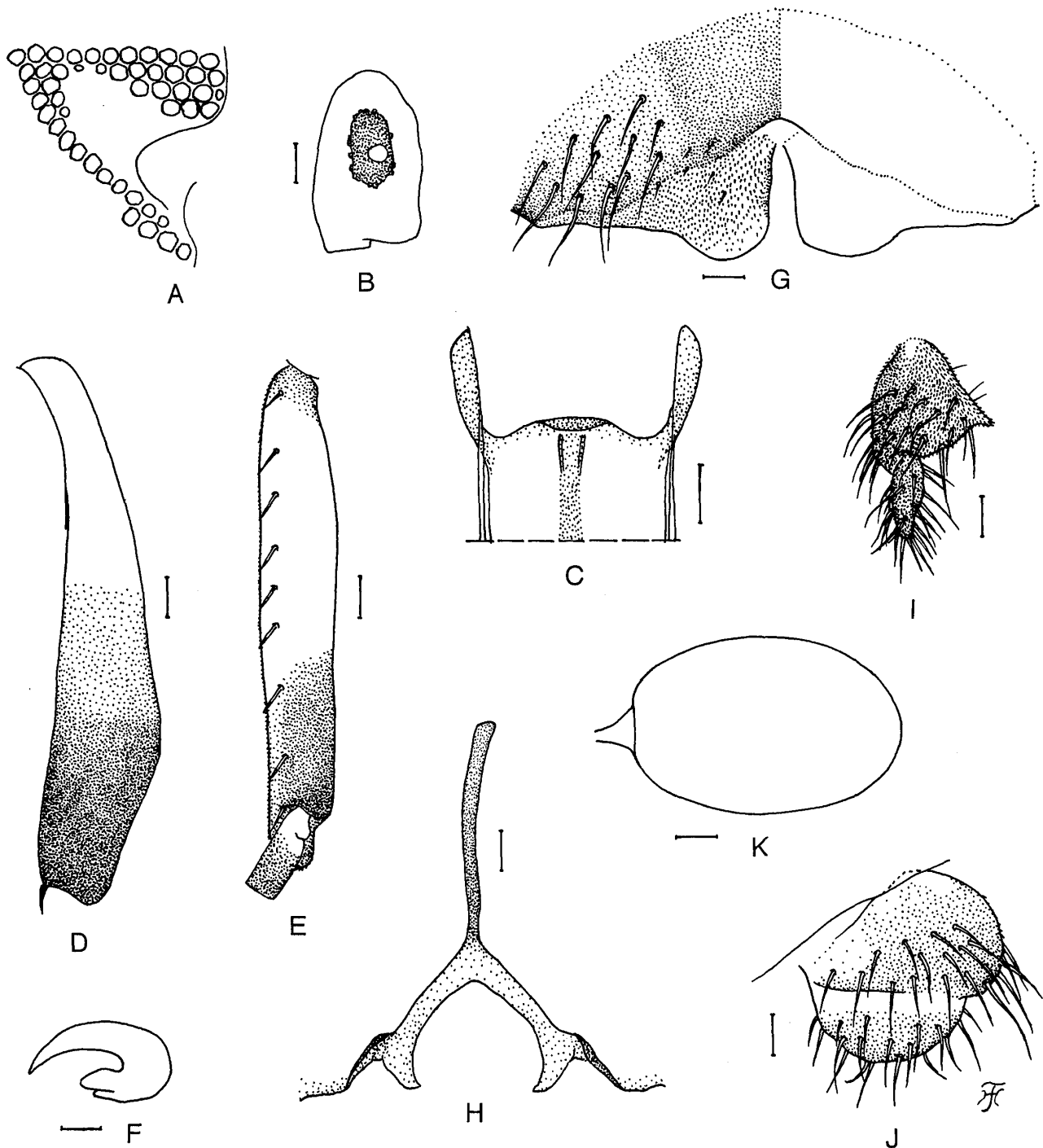


Fig. 3. Female of *Simulium* (*Gomphostilbia*) *bataksense* sp. nov. A, fronto-ocular area (right side); B, 3rd segment of maxillary palp with sensory vesicle (right side and front view); C, cibarium; D, hind tibia (left side and outer view); E, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); F, claw; G, 8th sternite and ovipositor valves *in situ* (ventral view); H, genital fork (ventral view); I and J, paraprocts and cerci *in situ* (right side; I, ventral view; J, lateral view); K, spermatheca. Scale bars. 0.04 mm for D and E; 0.02 mm for A–C and G–K; 0.01 mm for F.

brown; sternal plate on segment 7 undeveloped. **Genitalia.** Sternite 8 (Fig. 3G) bare medially, with 12 medium-long to long hairs together with a few short slender hairs on each side. Ovipositor valves (Fig. 3G) tongue-like,

with round medioposterior corners, thin, membranous, moderately covered with microsetae interspersed with 2 short setae; inner margins slightly sinuous or concave, moderately sclerotized, and moderately separated from

each other. Genital fork (Fig. 3H) of usual inverted-Y form, with arms of moderate width; arm moderately folded medially and with projection directed posteromedially. Paraproct in ventral view (Fig. 3I) nearly triangular, pointed medially, and with about 4 sensilla on anteromedial surface; paraproct in lateral view (Fig. 3J) somewhat produced ventrally, with about 20 medium-long to long hairs on ventral and lateral surfaces. Cercus in lateral view (Fig. 3J) short, rounded posteriorly, 0.47 times as long as wide. Spermatheca (Fig. 3K) ellipsoidal, 1.5 times as long as its greatest width, well sclerotized except duct and small area near juncture to duct unsclerotized, and with many fissures on surface; internal setae absent; both accessory ducts slender, subequal in diameter to major one.

Pupa. Body length 2.5 mm. **Head.** Integument light yellow, moderately covered with small round or flat tubercles on frons (Fig. 4A), sparsely covered with small tubercles on narrow area on each lateral surface but bare on antennal sheath and most of face (Fig. 4B); antennal sheath without any projections; frons with 3 simple very long trichomes with uncoiled apex on each side, arising close together, subequal in length to one another (Fig. 4A); face with 1 simple long trichome with coiled or uncoiled apex on each side (Fig. 4A). **Thorax.** Integument light yellow, moderately covered with small round tubercles (though sparsely on most of dorsal surface), with 3 simple very long trichomes with coiled apex dorsomedially, with 2 simple trichomes (1 very long and 1 long) anterolaterally, with 1 simple medium-long trichome with uncoiled apex posterolaterally, and with 3 simple medium-long trichomes with uncoiled apex ventrolaterally, on each side. Gill (Fig. 4C) composed of 8 slender thread-like filaments, longer than pupal body, arranged in $[(1+2)+(1+2)]+2$ filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally (partially broken) at base; dorsal and middle triplets sharing short stalk arising from short common basal stalk; upper triplet composed of 1 individual and 2 paired filaments with short stalk, middle triplet composed of 1 individual and 2 paired filaments with medium-long stalk; stalk of ventral paired filaments long, slightly thinner than interspiracular trunk, slightly thicker than primary stalk of middle triplet which is slightly thicker than that of dorsal triplet; stalk of

upper triplet lying against that of ventral pair nearly at right angle when viewed laterally; all filaments light yellow except dorsal surface of basal common stalk dark brown, gradually tapered toward apical tip, slightly different in length and thickness from one another: i.e., inner filament of ventral pair longest (2.7 mm) and thickest of all, followed by outer filament of ventral pair which is slightly thinner (i.e., 0.8 times as thick as its counter inner filament) and probably slightly shorter than its counter inner filament (tips cut off, then exact length not measurable), filaments of dorsal triplet shortest (1.7–1.8 mm), those of middle triplet intermediate in length (1.9–2.1 mm), and filaments of dorsal and middle triplets subequal in thickness to one another, 0.66 times as thick as that of inner filament of ventral pair; cuticle of all filaments with very weakly developed annular ridges (often appearing indistinct), densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 pale yellow, almost bare, with 1 simple slender medium-long hair-like seta on each side; segment 2 pale yellow, bare, with 1 simple slender medium-long hair-like seta and 5 very short setae, submedially on each side; segments 3 and 4 mostly transparent, each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking spine-combs; segments 6–9 each with distinct spine-combs in transverse row [though spine-combs (Fig. 4D) on segment 9 much smaller in size than those on other segments], together with comb-like groups of minute spines on each side; segment 9 with pair of distinct flat plate-like terminal hooks extending laterally at base and having undulate outer margin (Fig. 4E). Ventrally, segment 4 with a few simple slender very short setae on each side; segment 5 with pair of bifid hooks submedially and a few very short simple slender setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat spaced from each other and a few very short simple slender setae on each side; segments 4–8 with comb-like groups of minute spines. Each side of segment 9 with 3 grapnel-shaped hooklets. **Cocoon** (Fig. 4F). Wall-pocket-shaped, thinly and neatly woven, extending ventrolaterally; anterior margin slightly thickly woven, without anterodorsal bulge or projection; posterior 1/2 with floor moderately woven; individual threads visible; 3.0 mm long by 2.0 mm wide.

Male and Mature larva. Unknown.

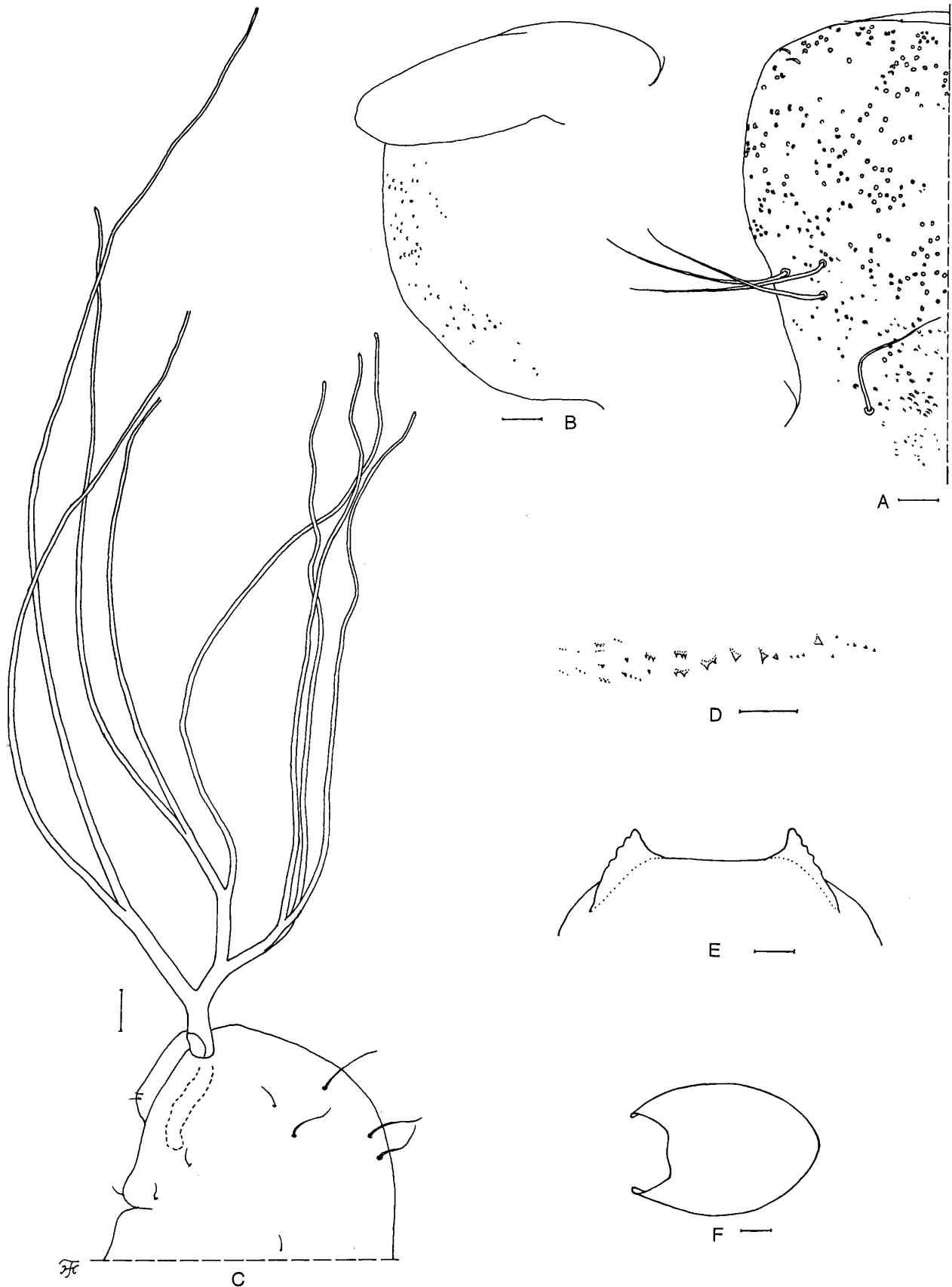


Fig. 4. Pupa of *Simulium* (*Gomphostilbia*) *bataksense* sp. nov. A, frons and portion of face (right half); B, lateral part of face (right side); C, gill filaments and anterior part of thoracic integument (left side and outer view), D, spine-combs and comb-like groups of minute spines on dorsal surface of abdominal segment 9 (left half and dorsal view); E, terminal hooks (end view); F, cocoon (dorsal view). Scale bars. 0.5 mm for F; 0.1 mm for C; 0.04 mm for A and B; 0.02 mm for D; 0.01 mm for E.

TYPE SPECIMEN. Holotype female (with its associated pupal exuviae) reared from a pupa collected from a small stream (Col. no. 9) (width 2–3 m, shaded, water temperature 25.0°C, altitude 47 m), Binduyan, near the road between Puerto Princesa and El Nido, 30. I. 2007, by H. Takaoka and V. F. Tenedero.

ECOLOGICAL NOTES. The pupa of this new species was taken from a trailing grass leaf in a slowly flowing small stream. Associated species was *S. (G.) epistum*.

ETYMOLOGY. The species name *bataksense* refers to the name of the tribe, Bataks, living in the place where this new species was collected.

REMARKS. According to the keys (Takaoka, 2003), *S. (G.) bataksense* sp. nov. is assigned to either the *batoense* species-group or the *ceylonicum* species-group of the subgenus *Gomphostilbia* by having antennae with 11 segments, bare pleural membrane, and claw with a large basal tooth (Fig. 3F) in the female, and eight gill filaments arranged as 3+3+2 (Fig. 4C) in the pupa. The final assignment to the species-group can not be done because the male of this new species is not available.

The female of this new species is distinguished from all the known species of the two species-groups by the hind tibia that is yellowish-white on a little more than the basal two-fifths and light to dark brown on the rest (Fig. 3D).

Like the preceding new species, *S. (G.) babuyanense* sp. nov., the inner filament of the ventral pair is somewhat longer and thicker than the other seven filaments (Fig. 4C). A similar arrangement of the pupal gill filaments is seen in *S. (G.) pegalanense* from Sabah (Smart and Clifford, 1969), but terminal hooks of this known species have no serrated outer margins, differing from those of *S. (G.) bataksense* sp. nov. (Fig. 4E). The arrangement of the eight pupal gill filaments separates this new species from all the nine known species of the *batoense* species-group and the one known species of the

ceylonicum species-group so far reported from the Philippines (Takaoka, 1983; Takaoka and Tenedero, 2007).

This new species is also distinguished in the pupa from *S. (G.) babuyanense* sp. nov. by the shorter length of gill filaments (maximum length 2.7 mm).

4. *Simulium (Gomphostilbia) epistum* Delfinado

Simulium (Gomphostilbia) epistum Delfinado, 1971: 136–137 (male); Takaoka, 1983: 63–66 (female, male, pupa and larva).

This species belongs to the *batoense* species-group and is characterized by pupal gills with the outer filament of the ventral pair much longer and thicker than the seven other filaments (Takaoka, 1983).

SPECIMENS EXAMINED. 16 females, 9 males, 6 mature larvae and 21 immature larvae, collected from the main channel of the Tukurong River (Col. no. 2) (width 4–8 m, water temperature 23°C, partially shaded, altitude 160 m) moderately flowing in a forest and crossing the road from Iwahig to Montible, Montible, 28. I. 2007, by H. Takaoka and V. F. Tenedero; 2 pupal exuviae collected from the same stream (Col. no. 3) as noted under *S. (G.) alienigenum*; 2 females, 6 males, 3 pupal exuviae, 7 mature larvae and 12 immature larvae, collected from the same stream (Col. no. 9) as noted under *S. (G.) bataksense* sp. nov.; 9 females, 10 males, 1 pupal exuviae, 12 mature larvae and 63 immature larvae, collected from the same river (Col. no. 13) as noted under *S. (G.) alienigenum*.

ECOLOGICAL NOTES. *Simulium (G.) epistum* is a common simuliid species in Palawan, and breeds in small to medium-sized shaded streams with slow to moderate flows. The pupae and larvae of this species were found on leaves of trailing grasses and fallen leaves in the water. Associated species were *S. (G.) alienigenum*, *S. (G.) bataksense* sp. nov., *S. (G.) mangasepi*, *S. (G.) montiblense*, *S. (S.) iwahigense*, *S. (S.) quasifrenum*, and *S. (S.)*

subatrum. None of the 107 larvae examined was infected with mermithids, microsporidians or fungi.

DISTRIBUTION. Philippines (Balabac and Palawan).

5. *Simulium (Gomphostilbia) mangasepi* Takaoka

Simulium (Gomphostilbia) mangasepi Takaoka, 1983: 73–74 (female, pupa and larva).

The pupal characteristics of this species include eight gill filaments directed forward very close together at least basally, and very long stalks of the ventral paired filaments, as well as cone-shaped terminal hooks, that were ascertained in the two pupae collected in this study, as shown in Fig 5A–E. In addition, relative lengths of the primary and secondary stalks of the two triplets of the gill vary greatly between the two pupae (e.g., Fig. 5A, B versus Fig. 5C, D) and also between the left and right gills of the same pupa (e.g., Fig. 5A versus Fig. 5B, or Fig. 5C versus Fig. 5D). The other pupal characteristics, which were not (or only briefly) described, include (1) two triplet groups of filaments sharing a short stalk, that is nearly as long as the common basal stalk (see Fig. 5B, D) (though these triplets share a short stalk on the right side, but are sessile on the left side according to the reexamination of the type specimen), (2) the fourth abdominal segment with one distinct bifid hook on each side of the ventral surface that is almost the same size as hooks on segments 5–7, (3) the last abdominal segment with distinct spine-combs dorsally (Fig. 5E) that are similar in size to those on segments 6–8, and (4) the last abdominal segment on each side with a few slender short setae each with 0–4 straight branches (in

place of the usual grapnel-shaped hooklets).

The male of *S. (G.) mangasepi*, which has been so far unknown, is here described for the first time based on males reared from pupae.

DESCRIPTION. **Male.** Body length 2.0 mm. **Head.** Wider than thorax. Upper eye consisting of 11 or 12 vertical columns and 13 or 14 horizontal rows of large facets. Face dark brown, white pruinose. Clypeus dark brown, densely covered with yellow scale-like short to medium-long hairs (mostly directed upwards) interspersed with several dark brown simple longer hairs near lower margin. Antenna composed of scape, pedicel and 9 flagellomeres, medium to dark brown except scape, pedicel, and base of 1st flagellomere whitish-yellow, and rest of 1st flagellomere and 2nd flagellomere dark yellow or light brown; 1st flagellomere elongate, 1.63 times as long as 2nd flagellomere. Maxillary palp with 5 segments, light brown [in 1 male, left palp normal (Fig. 6A) but right one abnormal with 3rd and 4th segments deformed and without sensory vesicle (Fig. 6B, C)]; proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.16 : 2.64 (1.00 : 1.17 : 3.09 in 1 male as shown in Fig. 6A); segment 3 of moderate size (Fig. 6D); sensory vesicle (Fig. 6D) nearly globular, small, 0.20 times as long as 3rd segment and with small opening [though 0.16 times as long as 3rd segment and with very small opening in 1 male as shown in Fig. 6A]. **Thorax.** Scutum black, with whitish-gray pruinose pattern composed of anterolateral triangular spot on each shoulder, and wide transverse band on prescutellar area, which is connected to anterolateral spots through wide band along each lateral margin; these pruinose areas shiny when viewed at certain angle of light; scutum densely covered with whitish-yellow short hairs interspersed with dark short hairs; scutellum brownish-black, with copper-colored short hairs and dark brown long upright hairs along posterior margin. Postnotum brownish-black, thinly

Fig. 5. Pupa of *Simulium (Gomphostilbia) mangasepi* Takaoka. A and B, gill filaments and anterior parts of thoracic integument of the same pupa (A, left side and dorsal view; B, only basal portion is shown; right side and outer view), C and D, basal portions of gill filaments of the different pupa (C, left side and dorsal view; D, right side and outer view); E, spine-combs and terminal hooks on dorsal surface of abdominal segment 9 (left half and dorsal view). Scale bars. 0.1 mm for A–D; 0.02 mm for E.



whitish-gray pruinose, and bare. Pleural membrane bare. Katepisternum dark brown, longer than deep, moderately covered with dark brown short hairs. **Legs.** Foreleg: coxa yellow; trochanter light brown with base dark yellow; femur light brown except apical cap medium brown; tibia medium brown except median outer portion light brown; tibia gray sheeny extensively on outer surface when illuminated at certain angle of light; tarsus brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 5.5 times as long as its greatest width. Midleg: coxa dark brown; trochanter light brown except base yellow; femur medium brown; tibia medium brown with extreme base dark yellow or light brown; tarsus dark brown. Hind leg: coxa dark brown; trochanter yellow; femur and tibia medium to dark brown with extreme base dark yellow and apical cap brownish-black; tarsus dark brown except basal 3/5 of basitarsus and a little less than basal 1/2 of 2nd tarsal segment yellowish though base of basitarsus dark brown; basitarsus (Fig. 6E) narrow, nearly parallel-sided, 5.57 times as long as wide, and 0.64 times as wide as greatest widths of tibia and femur; calcipala slightly shorter than width at base, and 0.43 times as wide as greatest width of basitarsus. **Wing.** Length 1.4 mm. Costa with dark spinules and hairs. Subcosta bare. Hair tuft on stem vein dark brown. Basal portion of radius fully haired; R_1 with dark spinules and hairs; R_2 with hairs only. Basal cell absent. **Abdomen.** Basal scale dark brown, with fringe of light brown hairs. Dorsal surface of abdomen medium to dark brown except basal 1/2 of 2nd segment light brown, and covered with dark short to long hairs; segments 2 and 5–7 each with pair of thin whitish-gray pruinose dorsolateral patches, of which those on segment 2 broadly connected in middle to each other, and those on segments 5–7 narrowly connected to each other along anterior margin; all these patches shiny when viewed at certain angle of light; part of each lateral surface of segment 8 also shiny when viewed at certain angle of light. **Genitalia.** Coxite in ventral view (Fig. 6F) nearly rectangular, about 1.6 times as long as its greatest width. Style in ventral view (Fig. 6F) slender, tapered toward apex, 0.82 times as long as coxite, gently bent inward, with apical spine; style in ventrolateral view (Fig. 6G) very slightly tapered toward apex, with round apex. Ventral plate in ventral

view (Fig. 6F), transverse, 0.66 times as long as wide, nearly parallel-sided, with anterior margin produced anteromedially and shallowly concave medially (bluntly convex medially in 1 male), and with posterior margin slightly convex medially (nearly straight or very slightly concave medially in 1 male), and densely covered with microsetae on ventral surface; basal arms of moderate length, nearly parallel-sided; ventral plate in lateral view (Fig. 6H) moderately produced ventrally; ventral plate in end view (Fig. 6I) rounded ventrally, and densely covered with microsetae on posterior surface. Median sclerite (Fig. 6F) wide, plate-like, connected to ventral plate medially. Paramere, aedeagal membrane, and ventral surface of 10th abdominal segment nearly as in *S. (G.) babuyanense* sp. nov. Cercus similar in shape to that of *S. (G.) babuyanense* sp. nov., but encircled with 13–18 hairs.

SPECIMENS EXAMINED. 2 males reared from pupae collected from the same stream (Col. no. 3) as noted under *S. (G.) alienigenum*. Holotype female with its associated pupal exuviae (Bishop 12752) loaned from B. P. Bishop Museum.

ECOLOGICAL NOTES. The pupae of this species were collected from leaves of trailing grasses in a slowly flowing small stream. Associated species were *S. (G.) alienigenum*, *S. (G.) epistum*, *S. (S.) latis-tylum* and *S. (W.) tuyense*.

DISTRIBUTION. Philippines (Palawan).

REMARKS. The assignment of this species to the species-group, either the *batoense* species-group or the *ceylonicum* species-group, within the subgenus *Gomphostilbia* has remained undetermined because the male was not available. The males of this species examined in this study have a slender hind basitarsus (Fig. 6E), revealing that *S. (G.) mangasepi* can be reliably placed in the *batoense* species-group.

The male of *S. (G.) mangasepi* is similar to *S. (G.) babuyanense* sp. nov. in several features including the color of the legs, but is easily distinguished from the latter by the number of enlarged upper-eye facets, and the scutal pattern.

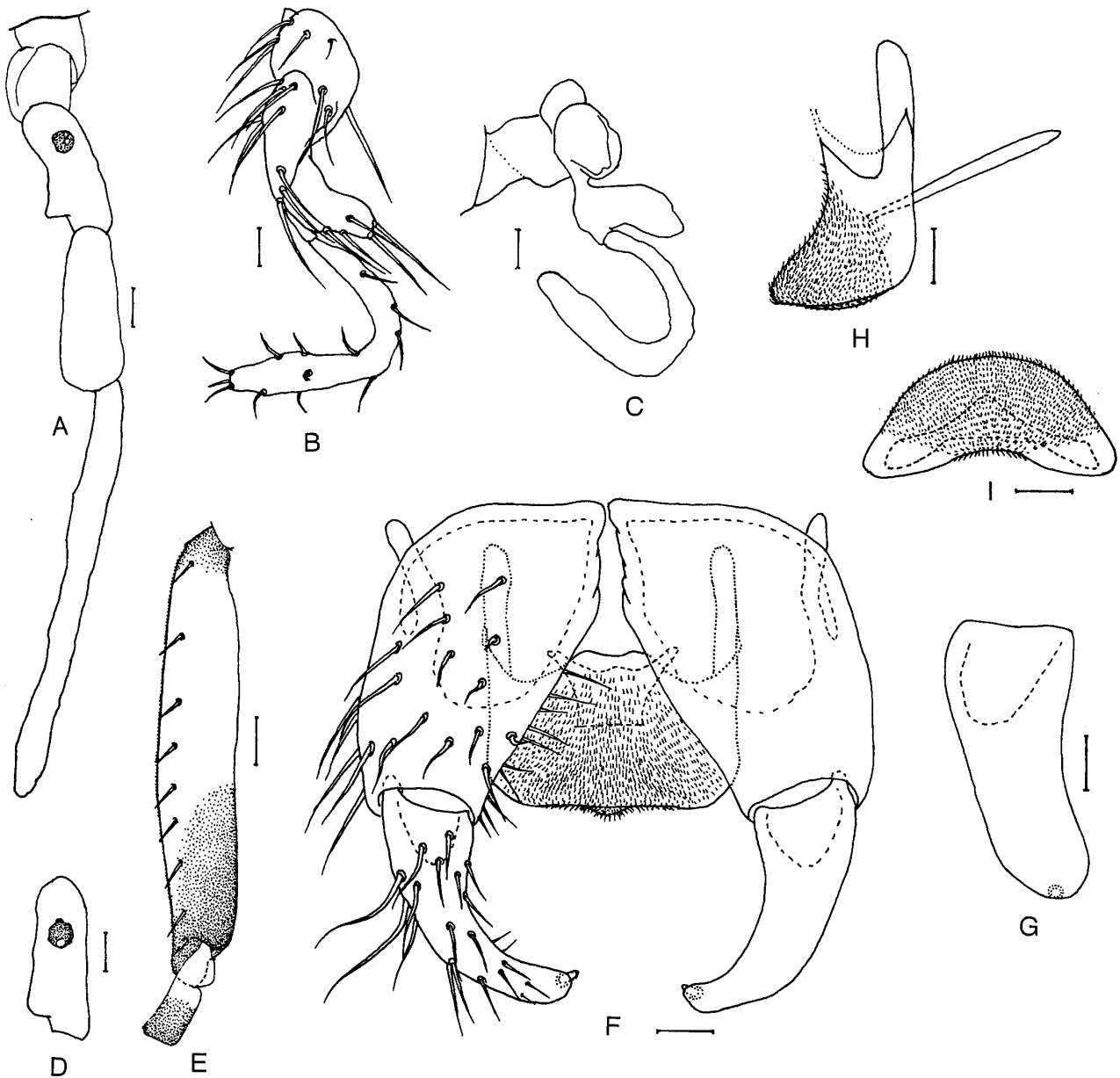


Fig. 6. Male of *Simulium (Gomphostilbia) mangasepi* Takaoka. A-C, maxillary palps of the same male (A, left side and frontal view; B and C, right side; B, front view; C, lateral view); D, 3rd maxillary palpal segment of the different male (left side and frontal view); E, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); F, coxites, styles, median sclerite and ventral plate *in situ* (ventral view); G, style (right side and ventrolateral view); H, ventral plate and median sclerite (lateral view); I, ventral plate (end view). Scale bars. 0.04 mm for E; 0.02 mm for A-D and F-I.

6. *Simulium (Gomphostilbia) montiblense* Takaoka

Simulium (Gomphostilbia) montiblense Takaoka, 1983: 71-73 (female, male, pupa and larva).

This species belongs to the *batoense* species-group, and is characterized by its very short pupal gill filaments (Takaoka, 1983).

SPECIMEN EXAMINED. 1 pupa collected from the same river (Col. no. 2) as noted under *S. (G.) epistum*.

ECOLOGICAL NOTES. Only one pupa of this species was collected from a dead leaf in a mountainous stream. Associated species were *S. (G.) epistum*, *S. (S.) iwahigense*, *S. (S.) latistylum*, *S. (S.) quasifrenum*, and *S. (S.) subatrum*.

DISTRIBUTION. Philippines (Palawan).

7. *Simulium* (*Nevermannia*) *aureohirtum* Brunetti

Simulium aureohirtum Brunetti, 1911: 283–288 (male); Edwards, 1934: 134–137 (female, pupa and larva).

Simulium (*Nevermannia*) *aureohirtum*: Ogata, 1956: 61–62; Ogata, 1966: 129; Crosskey, 1987: 459; Takaoka and Roberts, 1988: 194–195; Crosskey and Lowry, 1990: 204; Takaoka and Davies, 1995: 87–88; Crosskey and Howard, 1997: 47; Takaoka, 2003: 37–45 (female, male, pupa and larva).

Simulium (*Eusimulium*) *aureohirtum*: Puri, 1933: 1–7; Ogata and Sasa, 1954: 325; Ogata, Sasa and Suzuki, 1956: 73; Crosskey, 1973: 423; Takaoka, 1976: 170–171; Takaoka, 1979: 382–384 (female, male, pupa and larva); Datta, 1983: 225; Takaoka and Suzuki, 1984: 11–12.

Eusimulium aureohirtum: Orie, Uemoto and Onishi, 1969: 1–13.

Simulium (*Eusimulium*) *tuaranense* Smart and Clifford, 1969: 40–43. Syn. by Crosskey 1973.

Simulium (*Eusimulium*) *philippinense* Delfinado 1962: 47–62. Syn. by Takaoka 1983.

Simulium (*N.*) *aureohirtum* belongs to the *ruficornis* species-group, and is known to be widely distributed in the Oriental Region and to be autogenous at least during the first ovarian development (Takaoka, 2003).

SPECIMENS EXAMINED. 1 pupa, 2 pupal exuviae, 3 mature larvae and 2 immature larvae, all collected from a very slowly flowing lowland stream (Col. no. 7) (width 0.3–1.0 m, shaded, water temperature 25.5°C, altitude 20 m) in a bamboo forest near the Mentis Bridge, Lucbuan, along the road from Puerto Princesa to El Nido, 30. I. 2007, by H. Takaoka and V. F. Tenedero.

ECOLOGICAL NOTES. Only one pupa, two pupal exuviae and a few larvae of this species were collected from dead bamboo leaves in a sluggish stream. No other species was collected from the same stream. No infections with any of mermithids, microsporidians and/or fungi were found

in the five larvae examined.

DISTRIBUTION. Oriental Region and parts of Palaearctic and Australasian Regions.

8. *Simulium* (*Simulium*) *iwahigense* Takaoka

Simulium (*Simulium*) *iwahigense* Takaoka, 1983: 116–118 (female, male, pupa and larva).

This species belongs to the *melanopus* species-group, and is characterized by its medium-sized body and slender parallel-sided male hind basitarsus (Takaoka, 1983).

SPECIMENS EXAMINED. 3 females, 5 males, 20 mature larvae and 86 immature larvae, collected from a slowly or moderately flowing lowland river (Col. no. 1) (width about 30 m, water temperature 25.0°C, exposed to sun, altitude 39 m) crossing the road from Iwahig to Montible, Montible, 28. I. 2007, by H. Takaoka and V. F. Tenedero; 6 females, 2 males and 7 immature larvae, collected from the same river (Col. no. 2) as noted under *S. (G.) epistum*; 1 male, collected from the same stream (Col. no. 3) as noted under *S. (G.) alienigenum*; 1 female, 2 males, 1 mature larva and 6 immature larvae, collected from a moderately flowing river just upstream of the Estrella Falls (Col. no. 4) (width about 20 m, partially shaded, water temperature 22.0°C, altitude 110 m), Narra, 29. I. 2007, by H. Takaoka and V. F. Tenedero; 13 females, 11 males, 19 mature larvae and 28 immature larvae, collected from the Kayulo Falls (Col. no. 6) (width 0.5–5.0 m, water temperature 24.5°C, exposed to sun, altitude 30–50 m), Bahile Village, 30. I. 2007, by H. Takaoka and V. F. Tenedero; 1 female, 4 males, 1 mature larva and 10 immature larvae, collected from an irrigation channel (Col. no. 11) (width 0.8–2.0 m, water temperature 22.0°C, shaded, altitude 73 m) moderately flowing in a palm forest near the Sabsahan Falls, Cabar, 31. I. 2007, by H. Takaoka and V. F. Tenedero; 3 females, 2 males, 5

mature larvae and 32 immature larvae, collected from the same river (Col. no. 13) as noted under *S. (G.) alienigenum*.

ECOLOGICAL NOTES. *Simulium* (S.) *iwahigense* is a common simuliid species in Palawan, and breeds in moderately flowing streams and rivers either shaded or exposed to the sun. The pupae and larvae of this species were collected from leaves of trailing grasses and fallen leaves in the water. Associated species were *S. (G.) alienigenum*, *S. (G.) epistum*, *S. (G.) mangasepi*, *S. (G.) montiblense*, *S. (S.) latistylum*, *S. (S.) quasifrenum*, and *S. (S.) subatrum*. None of the 215 larvae examined was infected with mermithids, microsporidians or fungi.

DISTRIBUTION. Philippines (Palawan).

9. *Simulium (Simulium) subatrum* Takaoka

Simulium (Simulium) subatrum Takaoka, 1983: 104–107 (female, male, pupa and larva).

This species also belongs to the *melanopus* species-group, and is characterized by its very large body size in all stages (Takaoka, 1983).

SPECIMENS EXAMINED. 4 females, 5 males, 5 mature larvae and 65 immature larvae, collected from the same river (Col. no. 2) as noted under *S. (G.) epistum*; 8 females, 7 males, 6 mature larvae and 53 immature larvae, collected from the same river (Col. no. 4) as noted under *S. (S.) iwahigense*; 1 female, 2 pupal exuviae, 14 mature larvae and 16 immature larvae, collected from the main channel of a mountainous river just upstream of the Mainit Falls (Col. no. 12)(width 3–6 m, water temperature 22.0°C, shaded, altitude 95 m) near Brooks Point, 31. I. 2007, by H. Takaoka and V. F. Tenedero.

ECOLOGICAL NOTES. *Simulium* (S.) *subatrum* breeds in shaded mountainous streams and rivers with moderate to rapid flows. The pupae and larvae of this species were collected from leaves of trailing grasses and fallen leaves or twigs in water

as well as from the surface of rocks or stones in the rapids. Associated species were *S. (G.) epistum*, *S. (G.) montiblense*, *S. (S.) iwahigense*, *S. (S.) latistylum*, and *S. (S.) quasifrenum*. Fungal infections with *Coelomycidium* sp. were found in two of the 53 immature larvae collected from Col. no. 4. No infections were found in the other larvae collected.

DISTRIBUTION. Philippines (Luzon and Palawan).

10. *Simulium (Simulium) latistylum* Takaoka

Simulium (Simulium) latistylum Takaoka, 1983: 128–129 (male, pupa and mature larva).

This is the only member of the *nobile* species-group so far reported from Palawan Island (Takaoka, 1983). The illustration of the pupal gill filaments (Fig. 7A) is shown because it was not given in the original description (Takaoka, 1983). The frons of the pupa is nearly bare except for the lower area and the lateral narrow areas along the lateral margins that are moderately or sparsely covered with small tubercles; the thoracic integument is also mostly bare except for the posterodorsal area and the lateral areas that are sparsely or moderately covered with small tubercles. The distribution of the tubercles on the head and thoracic integuments was not described in detail in the original description (Takaoka, 1983).

The female of this species, which has been so far unknown, is here described for the first time based on females reared from pupae.

DESCRIPTION. **Female.** Body length 1.7–1.9 mm. **Head.** Slightly narrower than width of thorax. Frons black, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.17 : 1.00 : 1.26; frons-head ratio 1.0 : 4.3. Fronto-ocular area (Fig. 8A) shallow, not deeply extended laterally. Clypeus black, shiny, whitish pruinose, silvery iridescent when illuminated, moderately covered with

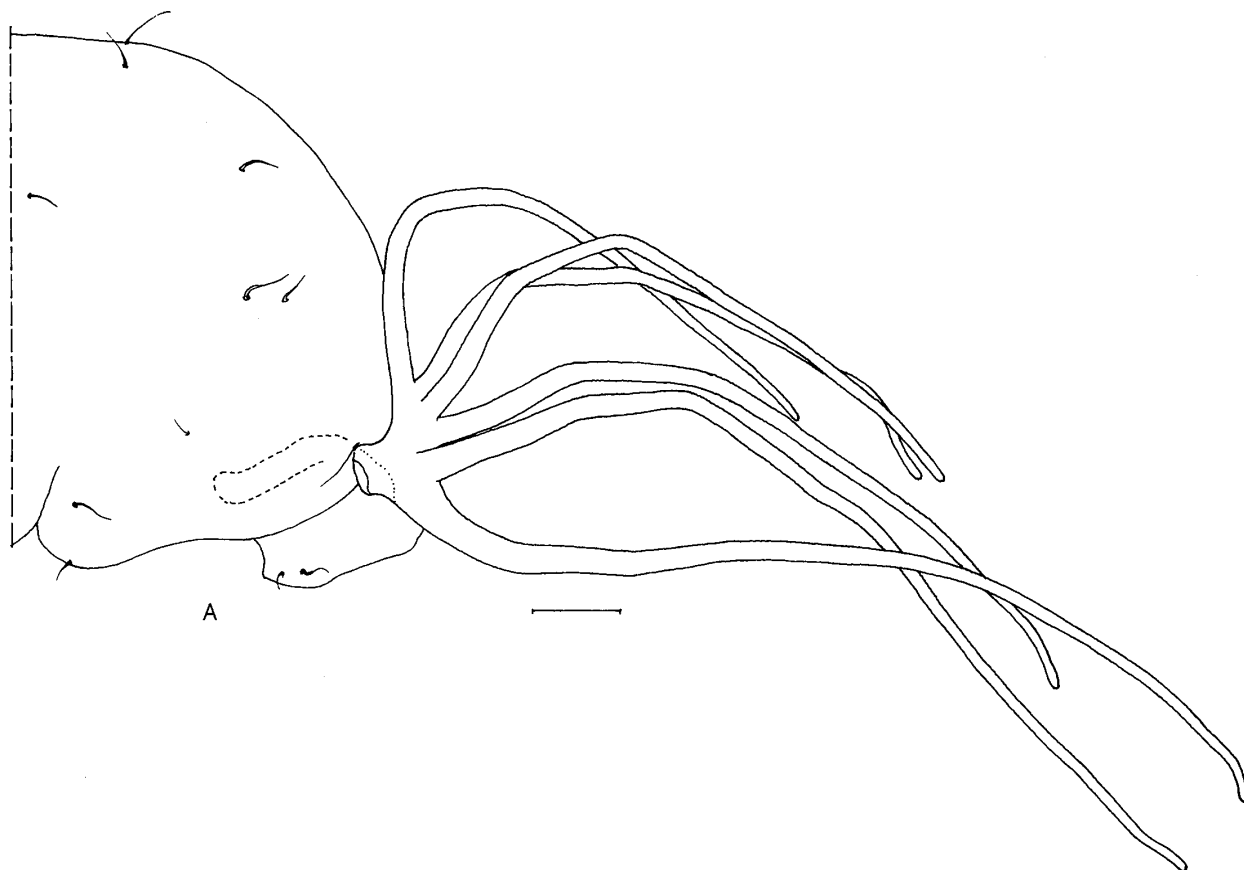


Fig. 7. Pupa of *Simulium* (*Simulium*) *latistylum* Takaoka. A, gill filaments and anterior part of thorax (right side and outer view). Scale bar. 0.1 mm for A.

dark stout hairs except most of medial portion sparsely covered with similar stout hairs. Labrum 0.54 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown except scape, pedicel and base of 1st flagellomere yellow. Maxillary palp brownish, composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.24 : 2.48; 3rd segment (Fig. 8B) of moderate size; sensory vesicle (Fig. 8B) small, nearly globular or ellipsoidal, 0.25–0.28 times as long as 3rd segment, with small opening medially. Maxillary lacinia with 9 or 10 inner and 10 outer teeth. Mandible with 19 or 20 inner and 9–11 outer teeth. Cibarium (Fig. 8C) with dark strongly sclerotized posterodorsal margin, and armed with numerous well-developed spinous processes. **Thorax.** Scutum brownish-black to black, shiny, thinly gray pruinose, not patterned, moderately covered with ocherous and dark brown recumbent short hairs. Scutellum brownish-black, with dark long hairs. Postnotum brownish-black, shiny, silvery iridescent when illuminated, without hairs. Pleural membrane bare. Katepisternum longer

than deep, and bare. **Legs.** Foreleg: coxa and trochanter yellowish-white; femur dark yellow or tawny basally, gradually darkened toward apical end; tibia brownish-black, with large area of silvery sheen on outer surface; tarsus brownish-black, with moderate dorsal hair crest; basitarsus much dilated, 4.6 times as long as its greatest width. Midleg: coxa black; trochanter, femur and tibia brownish-black, tibia with large area of silvery sheen on posterior surface when illuminated; tarsus almost yellowish-white except apical tips of basitarsus, 2nd and 3rd segments and most of 4th segment light brown, and 5th segment entirely dark brown. Hind leg: coxa brownish-black; trochanter yellowish-white; femur brownish-black except extreme base yellowish-white; tibia brownish-black, with large area of silvery sheen on posterior surface when illuminated; tarsus yellowish-white except apical 3/10 of basitarsus brownish-black, apical 1/2 or a little less of 2nd segment and all of 3rd and 4th segments light brown, and all of 5th segment medium to dark brown; basitarsus (Fig. 8D) nearly parallel-sided, 5.30

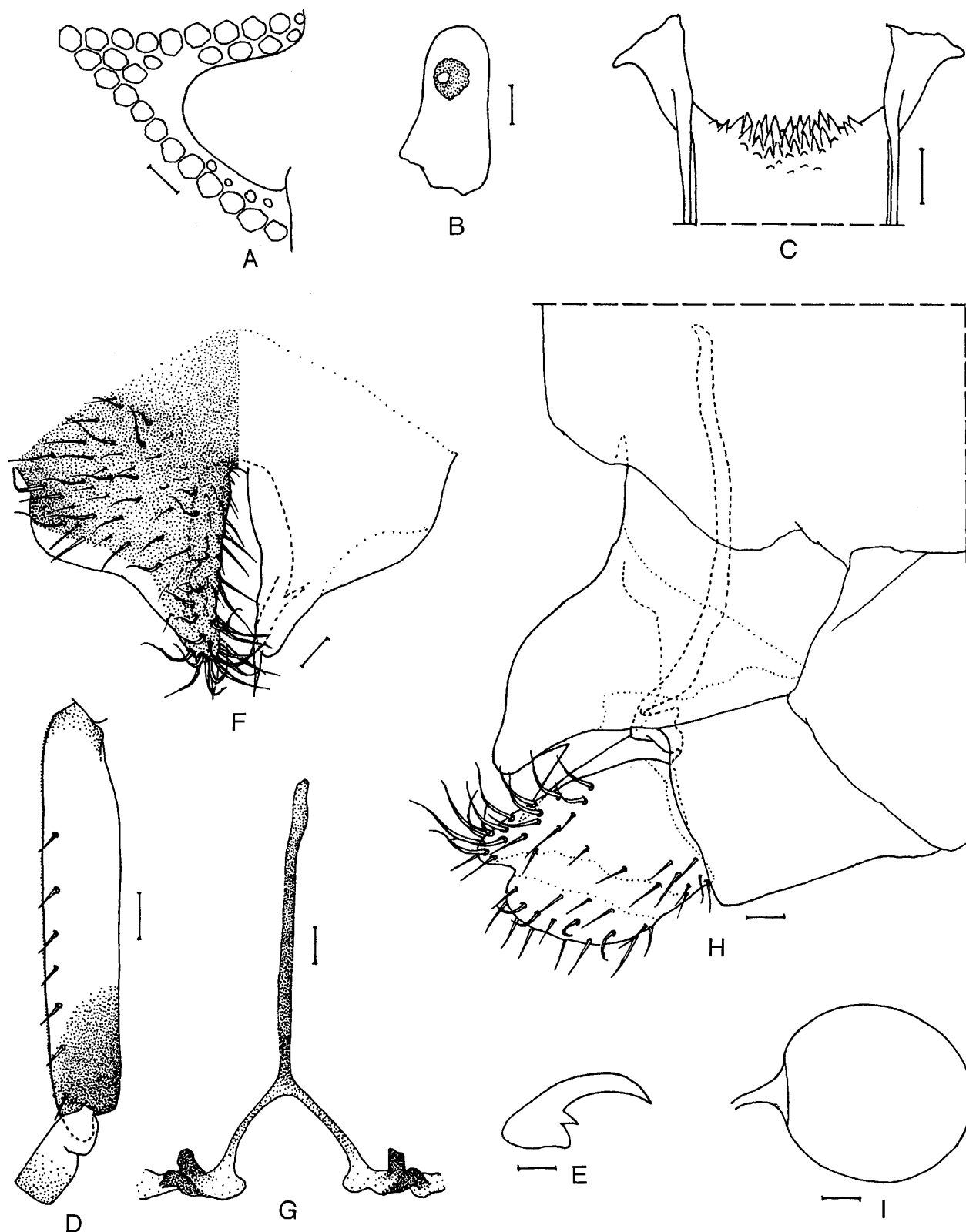


Fig. 8. Female of *Simulium* (*Simulium*) *latistylum* Takaoka. A, fronto-ocular area (right side); B, 3rd segment of maxillary palp with sensory vesicle (left side and front view); C, cibarium; D, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); E, claw; F, 8th sternite and ovipositor valves *in situ* (ventral view); G, genital fork (ventral view); H, posterior tip of abdomen showing paraproct, cercus and genital fork (lateral view); I, spermatheca. Scale bars. 0.04 mm for D; 0.02 mm for A-C and F-I; 0.01 mm for E.

times as long as wide, 0.63 and 0.52 times as wide as greatest widths of hind tibia and femur, respectively; calcipala well developed, nearly as long as wide and 0.41 times as wide as basitarsus; pedisulcus well developed. Claw (Fig. 8E) with small subbasal tooth. Outer surfaces of femora and tibiae of mid and hind legs densely covered with scale-like hairs as well as usual simple hairs. **Wing.** Length 1.4–1.5 mm; costa with dark spinules and hairs. Subcosta bare. Basal section of vein R bare; R_1 with dark spinules as well as a few dark hairs; R_2 with dark hairs only. Hair tuft of stem vein dark brown. Basal cell absent. **Abdomen.** Basal scale black, with fringe of dark hairs; dorsal surface of abdomen dark brown to brownish-black, sparsely covered with dark hairs; 2nd segment with large silvery iridescent dorsolateral spots broadly connected to each other in middle; tergites 6–8 large and shiny. Ventral surface of segment 7 lacking sternal plate. **Genitalia.** Sternite 8 (Fig. 8F) well sclerotized, bare medially, with many long stout hairs as well as short slender hairs laterally on each side; sternite 8 markedly produced posteromedially and also somewhat ventrally, forming triangular submedian lobes with rounded apex, each lobe covered with many long and short hairs, folded dorsally along inner margin and having narrow nearly-transparent bare projection sharply pointed backwardly which extends beyond posterior tip of lobe; inner margins of lobes nearly straight or slightly concave medially, moderately separated from each other. Ovipositor valves (Fig. 8F) much reduced, and discernible as narrow membranous area connected to each posterolateral margin of sternite 8. Genital fork (Fig. 8G) of inverted-Y form, with long well-sclerotized stem; arms slender, each with strongly sclerotized apical ridge having short projection directed anterodorsally. Paraproct in lateral view (Fig. 8H) well sclerotized, subtriangular, 0.7 times as long as wide, produced ventroposteriorly beyond level of ventral margin of cercus, with many long stout hairs ventrally and laterally, and with several short slender hairs near posterior margin and near dorsal margin; ventral surface narrow, not plate-like but rounded. Cercus in lateral view (Fig. 8H) short, subquadrate or rounded posteriorly, 3.2 times as wide as its length, covered with several short hairs. Spermatheca (Fig. 8I) ovoidal, well sclerotized except duct and large

area near juncture to duct unsclerotized, with weakly and irregularly defined surface patterns and with minute internal setae; both accessory ducts subequal in diameter to each other and also subequal to main duct.

SPECIMENS EXAMINED. 13 females, 10 males, 4 mature larvae and 37 immature larvae, collected from the same river (Col. no. 1) as noted under *S. (S.) iwahigense*; 3 females and 1 male, collected from the same river (Col. no. 2) as noted under *S. (G.) epistum*; 1 male, collected from the same stream (Col. no. 3) as noted under *S. (G.) alienigenum*; 10 females, 6 males, 12 mature larvae and 18 immature larvae, collected from an irrigation ditch (Col. no. 5) (width 0.8–1.0 m, water temperature 23.0°C, exposed to sun, altitude 90 m) slowly flowing in the lowland rice field near the Estrella Falls (Col. no. 4), 29. I. 2007, by H. Takaoka and V. F. Tenedero; 1 male, collected from the same stream (Col. no. 11) as noted under *S. (S.) iwahigense*; 1 female and 1 male, collected from the same river (Col. no. 13) as noted under *S. (G.) alienigenum*.

ECOLOGICAL NOTES. *Simulium (S.) latistylum* is a common simuliid species in Palawan, and breeds in various aquatic habitats from small irrigation channels to large rivers with slow to moderate flows. The pupae and larvae of this species were collected from leaves of trailing grasses and fallen leaves in the water. Associated species were *S. (G.) alienigenum*, *S. (G.) epistum*, *S. (G.) montiblense*, *S. (S.) iwahigense*, *S. (S.) quasifrenum*, and *S. (S.) subatrum*. Fungal infection with *Coelomycidium* sp. was found in one of the 12 mature larvae collected from Col. no. 5. No infections were found in all the 18 immature larvae collected from Col. no. 5 and in all the 41 larvae collected from Col. no. 1.

DISTRIBUTION. Philippines (Palawan).

11. *Simulium* (*Simulium*) *quasifrenum* Delfinado

Simulium quasifrenum Delfinado, 1971: 133–134 (male).

Simulium (*Simulium*) *quasifrenum*: Takaoka, 1983: 131–134 (female, male, pupa and larva).

This is the only species of the *tuberosum* species-group in the Philippines (Takaoka, 1983).

SPECIMENS EXAMINED. 20 females, 28 males, 25 mature larvae and 41 immature larvae, collected from the same river (Col. no. 2) as noted under *S. (G.) epistum*; 2 females, 5 males, 4 mature larvae and 13 immature larvae, collected from the same river (Col. no. 4) as noted under *S. (G.) iwahigense*; 1 female, 1 male, 10 mature larvae and 11 immature, collected from a moderately flowing river just downstream of the Sabsaban Falls (Col. no. 10) (width about 10 m, water temperature 21.0°C, exposed to sun, altitude 78 m) near Brooks Point, 31. I. 2007, by H. Takaoka and V. F. Tenedero; 11 females, 6 males, 1 mature larva and 11 immature larvae, collected from the same irrigation channel (Col. no. 11) as noted under *S. (S.) iwahigense*; 4 females, 4 males, 6 mature larvae and 15 immature larvae, collected from the same stream (Col. no. 12) as noted under *S. (S.) subatrum*; 2 females, 5 males, 2 mature larvae and 9 immature larvae, collected from the same river (Col. no. 13) as noted under *S. (G.) alienigenum*.

ECOLOGICAL NOTES. *Simulium* (*S.*) *quasifrenum* is a common simuliid species in Palawan, and breeds in moderately to rapidly flowing streams and rivers in mountainous areas. The pupae and larvae of this species were collected from leaves of trailing grasses and fallen leaves in the water. Associated species were *S. (G.) alienigenum*, *S. (G.) epistum*, *S. (G.) montiblense*, *S. (S.) iwahigense*, *S. (S.) latistylum* and *S. (S.) subatrum*. None of the 148 larvae examined was infected with mermithids, microsporidians or fungi.

DISTRIBUTION. Philippines (Palawan).

12. *Simulium* (*Wallacellum*) *tuyense* Takaoka

Simulium (*Wallacellum*) *tuyense* Takaoka, 1983: 38–39 (male, pupa and larva).

SPECIMENS EXAMINED. 1 female, 1 male and 2 pupal exuviae, collected from the same stream (Col. no. 3) as noted under *S. (G.) alienigenum*.

ECOLOGICAL NOTES. The pupae of this species were collected from leaves of trailing grasses. Associated species were *S. (G.) alienigenum*, *S. (G.) mangasepi* and *S. (S.) latistylum*.

DISTRIBUTION. Philippines [Luzon, Mindoro and Palawan (**new record**)].

REMARKS. This species, which has been recorded from Luzon and Mindoro Islands, is here recorded from Palawan Island for the first time. The female of *S. (W.) tuyense* so far undescribed will be described on the basis of the specimens collected from the type locality of Luzon Island in a separate paper.

ACKNOWLEDGEMENTS

We are grateful to Prof. Lilian A. de las Llagas, University of the Philippines, for her support to this study. Thanks are due to Dr. Keith Arakaki, Entomology, B.P. Bishop Museum, Honolulu, Hawaii, U.S.A., who kindly arranged the loan of the type specimen of *S. (G.) mangasepi*.

This study was financially supported by a Grant-in-Aid for Oversea Research from the Japan Society for the Promotion of Science (No. 18406011).

REFERENCES

- Crosskey, R. W. 1990. The Natural History of Blackflies. ix + 711 pp., John Wiley & Sons, New York.
- Delfinado, M. 1971. Some Simuliidae and Curtonotidae from the Philippines and the Bismarck Islands (Insecta, Diptera). *Steenstrupia*, 1: 131–139.
- Edwards, F. W. 1934. The Simuliidae (Diptera) of Java and Sumatra. *Arch. Hydrobiol.*, 13 Suppl.

- "Tropische Binnengewässer" 5: 92-138.
- Smart, J. and Clifford, E. A. 1969. Simuliidae (Diptera) of Sabah (British North Borneo). *Zool. J. Linn. Soc.*, 48: 9-47.
- Takaoka, H. 1983. The Blackflies (Diptera: Simuliidae) of the Philippines. xii + 199 pp., Japan Society for the Promotion of Science, Tokyo.
- Takaoka, H. 1991. A revisionary note on the blackfly, hitherto called "*Simulium (Gomphostilbia) batoense* Edwards, 1934" from the Ryukyu Islands, Japan (Diptera: Simuliidae). *Jpn. J. Trop. Med. Hyg.*, 19: 265-273.
- Takaoka, H. 2003. The Black Flies (Diptera: Simuliidae) of Sulawesi, Maluku and Irian Jaya. xxii + 581 pp., Kyushu University Press, Fukuoka.
- Takaoka, H. and Suzuki, H. 1984. The blackflies (Diptera: Simuliidae) from Thailand. *Jpn. J. Sanit. Zool.*, 35: 7-45.
- Takaoka, H. and Tenedero, V. F. 2007. Two new and four newly recorded species of *Simulium* (Diptera: Simuliidae) from Mindoro Island, the Philippines. *Med. Entomol. Zool.*, 58: 29-48.